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Technical Advisor to the American Indian Research and Education Initiatives (AIREI)

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1 Introduction

The American Indian Research & Education Initiative (AIREI) is a pilot program that started in 2011 and is funded by the US Department of Energy (DOE) Economic Impact & Diversity and National Nuclear Security Administration in partnership with the American Indian Higher Education Consortium (AIHEC) and the American Indian Science and Engineering Society. AIREI brings science, technology, engineering, and mathematics (STEM) research and education funding to Tribal Colleges and Universities (TCU) and other US universities. AIREI has funded eight schools, including four pairs of tribal colleges and mainstream universities, in order for student and faculty research teams to bring energy projects to tribal lands. The research team from Southwest Indian Polytechnic Institute (SIPI) and Northern Arizona University (NAU) has performed a student-centric research and analysis feasibility study of a potential utility-scale solar power plant on the Jemez Pueblo reservation trust land. The research team from Navajo Technical University (NTU) and Arizona State University (ASU) has assessed the effectiveness of solar photovoltaic (PV) system designs in meeting the electricity demands of Navajo Tribal homes and public buildings in addition to the development of a solar technology curriculum that incorporates the outcomes of this study, helping to advance PV system design and installations on local Tribal lands. The Little Big Horn College (LBHC) and Montana State University-Bozeman (MSUB) team has developed fast growing strains of nitrogen-fixing cyanobacteria to help advance carbon capture and sequestration (CCS) technologies. The research supported the Crow Nation reservation as it evaluates opportunities for coal-to-liquid fuel and CCS projects. The Sinte Gleska University (SGU) and South Dakota School of Mines (SDSM) team developed computer modeling and simulation technologies to evaluate the feasibility of oil and gas development from the Niobrara Formation on the Rosebud Sioux reservation. Through this project, the students developed skills in applied energy-related research involving computer simulation, chemistry, geology, and petroleum engineering. AIREI supports collaboration between these universities and connects the teams with the technological expertise and mentorship opportunities provided through Sandia National Laboratories (Sandia). AIHEC consists of 37 American Indian tribally controlled colleges around the nation and provides technical assistance through professional development workshops, strategic planning meetings, and information sharing strategies.

2 Sandia's Technical Assistance Summary

A Strategic Partnership Plan (SPP), formally Work-for-Others agreement, was signed between Sandia and AIHEC on July 11, 2012. The main focus of Sandia's contribution is to ensure the data collection and analysis are appropriate for the research goals of the overall AIREI project, support data analysis and research outcomes, conduct site visits, and review reports delivered by the various entities described above. The SPP did not include contribution to the SGU and SDSM team project and thus the following sections will only summarize Sandia's contributions to the SIPI, NAU, NTU, ASU, LBHC, and MSUB project team members. In addition to the contributions below, Stan Atcitty of Sandia's Energy Storage Technology and Systems Department, had numerous phone teleconferences and some face-to-face meetings with AIHEC to provide advice on the direction of the program, potential Sandia contributions, technical consulting on energy systems, and student mentorship opportunities.

2.1 SIPI and NAU Feasibility Study on Jemez Utility-scale Solar Power Plant

SIPI and NAU faculty and students, with technical support from Sandia, conducted a feasibility study of a utility-scale solar power plant on the Jemez Pueblo trust land located approximately 60 miles northwest of Albuquerque, New Mexico. The Jemez pueblo is interested in investigating the potential development of a utility-scale 40MW solar power plant that interconnects a nearby transmission system. The proposed system will eventually be used to sell electrical power off the reservation to increase internal revenue. Four solar power types were used for the techno-economic evaluation using the System Advisory Model (SAM): 1) fixed-axis, horizontal solar PV; 2) fixed-axis, tilted (at latitude) solar PV; 3) 1-axis, horizontal PV; and 4) concentrating solar, molten salt thermal power plant. The results showed that all four power plant options demonstrated positive net present value for the Tribe; however, the cost of interconnecting to the transmission system will be a major cost and will need to be considered in future studies. The outcome of this project was presented at the American Solar Energy Society's National Solar Conference in 2014[1].

Stan mentored three American Indian students (two undergraduate and one graduate) at NAU and several SIPI students during the course of this project. Stan was appointed an adjunct faculty member at NAU in 2015. Because of the quality of the work, Cherise John, a member of the Navajo Tribe, was able to graduate with a master's degree in mechanical engineering. Cherise is now gainfully employed at General Electric (GE) in Cincinnati as a mechanical engineer. Furthermore, she was admitted into GE's Edison Scholars program where employees are trained to be future leaders. The overall project goals were exceeded, as American Indian students were involved in a real-life engineering analysis that could benefit a Tribe. It provided an excellent example of how each student can give back to their respective Tribes.

[1] Acker, T.L., John, C., DeVore, K., Tallas, S., Khatibi, M., Vadee, N., West, J., Collins, M., Billie, T., and S. Atcitty (2014). Jemez Pueblo solar power study. In 43rd ASES National Solar Conference 2014, SOLAR 2014, Including the 39th National Passive Solar Conference and the 2nd Meeting of Young and Emerging Professionals in Renewable Energy. (Vol. 2, pp. 1129-1136). American Solar Energy Society.

2.2 NTU and ASU Remote Power System Analysis on the Navajo Reservation

The overall goal was to conduct a technical study on off-grid renewable energy involving the efficiency, durability, and reliability of PV system and associated components. The first project was focused on data analysis and partial installations of six remote power systems on the western part of the Navajo Reservation. Each system provides much needed power to elderly homes scattered near Grand Falls, Arizona, and consists of PV arrays, charger controllers, batteries, inverters, and AC/DC loads. The NTU and ASU team performed field installations and energy supply/consumption data gathering and analysis. Stan accompanied the team on three field trips. During that time, Stan provided technical guidance on major system components including detailed information on batteries and inverters. Stan also mentored over 10 American Indian students during the course of this project.

The second project involved an off-grid renewable system that supplies power to a lighted sign located on the NTU campus to instruct students of any upcoming events. This installation was used to educate the NTU students on how to install such systems, gather data, perform electrical performance analysis, and ultimately present the data in a meaningful fashion. The system consists of similar components as the systems in Grand Falls. Stan provided guidance and background information on system operation, performance, and key metrics. He also provided assistance in scoping out the data collection analysis tools including LabVIEW system design software for the project that enabled remote performance analysis. Because of Stan's technical contributions and mentorship, he was selected to deliver a keynote speech at NTU's 2015 spring graduation. A total of 85 students received their associate's and bachelor's degrees. NTU first became a university in 2013, and seven students received their first bachelor's degree in 2015. In addition, Stan has been approached by several NTU students for feedback on career choices and technical insights.

Since 2013, NTU has held a Research Day Competition every spring for science and engineering students. Stan judged over 40 posters in the 2014 and 2015 competitions but was not able to attend the 2016 competition due to a conflict with travel.

Stan was appointed the Chair of Engineering Advisory Board at NTU in the spring of 2016. The board assists with revisions to the engineering curriculum, the development of program goals, surveys to determine the skills needed by local and national industries, and new technology developments. The board is currently advising and assisting NTU's faculty members to position the school to obtain the Accreditation Board for Engineering and Technology (ABET) accreditation in the near future.

2.3 LBHC and MSUB Oil and Gas Simulation and Feasibility Study

The project with LBHC and MSUB was focused on training American Indian students in isolating and characterizing phototrophs that could be used to extract waste carbon dioxide (CO2) from the coal to liquid fuel conversion process and to provide organic fertilizer products. The objective of the project is to develop effective carbon capture and storage methods that would significantly reduce the carbon footprint of such systems. The results suggested that cyanobacteria can be used to

impart salt tolerance in crops, but their validity needs to be further investigated. The project also provided plenty of opportunities for the American Indian students to evaluate and plan their career goals through frequent contact with their mentors. Sandia provided several email correspondences with the LBCH and MSUB team regarding their technical reports.

LBCH toured Sandia in August 2015 to gain additional insight on energy related research and development (R&D) activities. Sandia provided background on various energy related programs including presentations from five American Indian students who participated in Sandia's summer internship program funded by DOE Office of Indian Energy. The LBCH team presented their research and highlighted their results of the project, which gave the students an opportunity to present their findings in front a wide technical audience.

3 Conclusion

Sandia's involvement in these three projects was a success. Sandia had the opportunity to provide a national laboratory perspective on STEM R&D to TCUs and mainstream universities. Overall, over 200 American Indian students were impacted during the course of this project. Valuable information such as technical insights on batteries, inverters, PV, associated components, operation, deployment, analysis, technical report writing, and mentorship were provided by Sandia. In return, Sandia has gained additional insights on the complexity and unique challenges of installing remote power systems on Tribal lands. This information is very useful for Sandia's on-going energy & climate core mission in which Sandia seeks to develop an energy future that is sustainable by using its capability to develop and deploy energy sources that are safer, cleaner, more economical, and less dependent on scarce natural resources.